The Ventilation Controlled Fire

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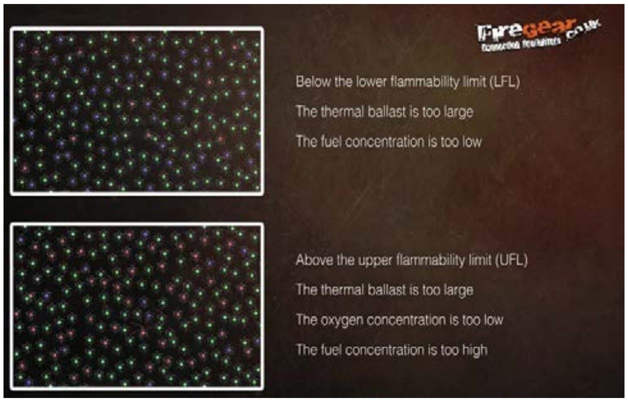
The fuel controlled fire is easy, well not easy, but in comparison to the ventilation controlled fire, you could say so. The fire in the fireplace, the TV or the couch is a fuel controlled fire. As long as you aim at brightest part, as long as you have more water than the fire needs then you have a good chance. Because the smoke produced is probably not combustible. The mixture of the smoke would in the past have been called lean, but it is a too simple description of why the smoke is not combustible.

However, fires in buildings often grow larger than that.
When the fire grows larger the available oxygen starts to run out and the effect of the fire, or heat output, is now governed by the amount of oxygen available. This mixture would in the past have been called rich, but again it is a too simple description. This transition to a ventilation controlled fire is a monumental difference compared to the fuel controlled fire. And it makes the incident much more difficult and perhaps dangerous. The understanding of how a ventilation controlled fire behaves is critical, and being able to identify it as well.

For combustion, or in other words oxidation to take place it needs an oxidizer which normally is oxygen, and it needs fuel and energy. The amount of heat that must be supplied for the process to start depends heavily on the amount of thermal ballast which is present in the mixture. Thermal ballast is often the missing link in training, a link that is important to understand to be able to understand fire behavior and fire extinguishing.

Thermal ballast is all molecules that cannot contribute to the process of oxidation. Nitrogen, water vapor and excess fuel and other inert particles act as heat sinks in the molecular soup and absorb heat. When too much thermal ballast exists in the mixture, even though a good blend of oxygen and fuel are present, it will not burn even if an ignition source is added. The blend between oxygen and fuel is not lean or rich but will still not burn due to the high amount of thermal ballast.



Fuel is often gases, gases coming from pyrolyzing natural materials or vaporized/pyrolysed oil-based materials such as plastic. To create these gases requires energy through heat and the process is quite slow, but it does not require oxygen. A hot environment without oxygen would then maybe still release fuel in gaseous form, fuel that normally would take a long time to release. This means that a ventilation controlled fire may have a very large amount of unburned fuel released in the smoke, smoke that can range from white and transparent to black and thick without knowing if it is combustible or not. The amount of unburned fuel in the smoke is now only acting as thermal ballast and absorbs energy since it lacks oxygen for combustion.

When we arrive to a ventilation controlled fire and make an opening, whether it be a window, door or a hole in the roof, we will change the course of the fire. The built up unburned fuel in the smoke will now burn with the same effect as the added supply of oxygen, a window give X effect, two windows give 2X effect etc. And if we add a wind or fan to that equation the fire effect greatly increases. It is the fires effect, not the temperature, which we primarily have to fight with our water which means that smaller openings give a better chance to extinguish the fire.

A good tactic at ventilation controlled fires might be to close all openings available to the fire to reduce the effect, and then cool the fire as close to the source of the fire as possible. A fog nail or piercing nozzle through the wall, or a nozzle through an opening and then closing it again are some of the methods we can use. If we manage to turn liquid water into water vapor the steam is now acting as thermal ballast, if there is enough water vapor in the smoke it cannot burn. Bear in mind that there is a difference between an indirect attack and gas cooling which both uses steam to inert smoke. When victims and firefighters are inside the smoke is cooled and diluted with steam without causing skin burns. By inerting the smoke we may be able to pause the fire, we probably cannot extinguish the fire but we are buying time and we can ventilate out smoke which is non-combustible when we enter.

To cool the smoke from the outside can be impractical at times, or may not be appropriate if there is life to be saved inside the building. If we instead go inside into a ventilation controlled fire, the same rules apply. If you open the door to go inside the oxygen that enters through the door will increase the effect of the fire and might cause the smoke to ignite. We need to cool the smoke and mix them with water vapor to reduce the risk of ignition. We also need to consider keeping the door closed against the hose behind the interior crew, we then reduce the risk of an increased effect of the fire and fire gases igniting.

Closing down the ventilation controlled fire and cooling the gases from the outside is a tactic that could be a good option in some cases. A name that could be used to describe that tactic is Anti Ventilation. Anti Ventilation works better and better the smaller and hotter the volumes are which are supposed to be suppressed because it is easier to create and fill the smaller volume with steam. Basements, attics and construction fire should generally be treated with an Anti Ventilation approach.

When we have a plan, resources available, and we have cooled the gases inside we can begin to tactically ventilate the building but that is a different topic.